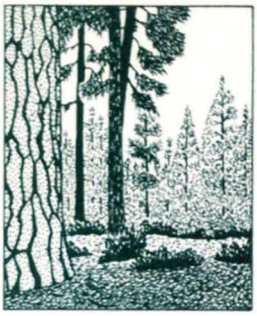
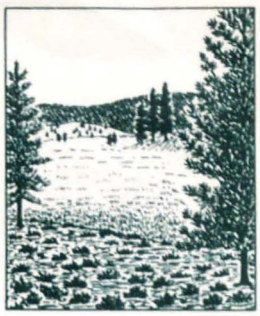


FOREST RESEARCH NOTES

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
KEITH ARNOLD, DIRECTOR

U.S. DEPARTMENT OF AGRICULTURE – FOREST SERVICE



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VARIATION IN LEADER LENGTH OF BITTERBRUSH [1/]

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MAY 15 1959
RESEARCH
INTERMOUNTAIN

The estimation of herbage production and utilization in browse plants has been a problem for many years. Most range technicians have simply estimated the average length of twigs or leaders, then expressed use by deer and livestock as a percentage thereof based on the estimated average length left after grazing. Riordan [3/] used this method on mountain mahogany (Cercocarpus montanus Raf.) and service berry (Amelanchier utahensis Koehne) and found that reliable estimates were virtually impossible. Measurements of 10,000 to 20,000 twigs or leaders were necessary with these two species for a reliable estimate of average length.

This same method has been used on bitterbrush (Purshia tridentata) through necessity, but without precise knowledge of the degree of reliability attained. Estimated average leader length in bitterbrush is a useful concept for determining seedling growth, planting success and levels of use by seasons, ranges and different kinds of grazing animals. But estimates must be sound and reliable. To learn how to obtain reliability and accuracy in our estimates we had to study variation in leader length.

1/ Contribution from cooperative investigation between the Experiment Station and the California Department of Fish and Game. Work was done under Federal Aid in Wildlife Restoration Act, Pittman-Robertson Research Project W51R, entitled "Game Range Restoration."

2/ Forestry Aid (Research) while working on this study. Presently a student at the University of California at Berkeley.

3/ Riordan, Laurence E., 1956. Some results of a ten-year study of deer-livestock competition for range forage. Paper presented at the tenth annual meeting of the American Society of Range Management at Great Falls, Montana, Mimeo. 14 pp.

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METHODS

We collected five ungrazed bitterbrush plants near Doyle, California, and cut off all current leaders. These bushes varied in size as follows:

Bush No.:	Height (Inches)	Average diameter (Inches)
1	45	53
2	58	53
3	87	57
4	49	47
5	57	55

These were cut during the winter, and the leaders which were clipped represented the preceding season's growth. We measured each leader to the nearest millimeter.

Determining just what was the past season's growth was not simple even though branching usually separated two successive years' growth. Sometimes, however, the current growth was merely an extension of previous growth, making it necessary to section the leaders for old wood.

The leaders were grouped into arbitrary length classes of 2.5 cm. Most of them fell into relatively few classes (table 1). The average leader length of each bush was greater than the upper limit of the class containing the most leaders.

RESULTS AND DISCUSSION

Since every twig was measured, it was possible to calculate the true variance for each bush and the sample size needed to estimate the true mean within 10 percent. The required sample in number of leaders for the various bushes was:

Plant no.:	Required sample
1	39
2	28
3	32
4	19
5	25

This range of 19 to 39 does not seem an unreasonable number of leaders to measure for average length.

The variation in leader length between bushes was much larger than that within bushes (table 2). Since the five bushes were of different sizes, the between-bush variation may not be too meaningful, but it suggests that many bushes may have to be sampled

Table 1.--Distribution of leader length by 2.5 cm. length classes for five bittertrush plants

Length classes cm.	Plant number				
	1	2	3	4	5
	Number of leaders				
0-2.5	16	31	13	2	28
2.6-5.0	351	274	239	6	346
5.1-7.5	271	176	179	91	389
7.6-10.0	159	159	121	172	310
10.1-12.5	117	95	86	120	239
12.6-15.0	111	66	44	91	131
15.1-17.5	72	24	21	79	88
17.6-20.0	57	10	26	64	35
20.1-22.5	42	8	8	34	9
22.6-25.0	20	--	4	25	5
25.1-27.5	13	--	2	11	2
27.6-30.0	3	--	1	6	--
30.1-32.5	2	--	--	6	--
32.6-35.0	1	--	1	1	--
35.1-37.5	--	--	--	1	--
All classes	1,235	843	745	709	1,582
Average length, cm.	9.28	7.53	7.97	13.07	8.49

to estimate accurately the average leader length of bitterbrush plants on an entire range. Also, site variation, which was not considered in this study, would probably increase the size of sample required.

Table 2.--Comparison of variance of bitterbrush leader length

Source of variation	d.f.	S sqs.	M. sq.
Between bushes	4	14,599.76	3,649.94
Within bushes	5108	123,151.47	241.09
TOTAL	5112	137,751.23	--

CONCLUSIONS

An unrestricted random sample of 19 to 39 leaders from each of the five bushes studied would have given a reliable estimate of the average leader length. The next problem is how to get this unrestricted random sample from growing plants. W. G. O'Regan, Station Statistician, in reviewing this paper commented that "the difficult problems are still to come." We couldn't be in closer agreement on this point.

We intend to tackle the problem of unrestricted random sampling by testing a number of sampling methods on growing bushes, cutting them, and then measuring all leaders. The study reported here will help design the next one.

Another problem is the variation due to grazing. This source of variation didn't bother us in the present study because the test plants were ungrazed. It will certainly be present, however, under most conditions where there is a need for estimating average leader length of bitterbrush.

Getting a sound estimate of average leader length isn't simple--a lot of sources of variation creep into the picture. We need a clear understanding of this variation to get on firm enough ground to make reliable estimates.